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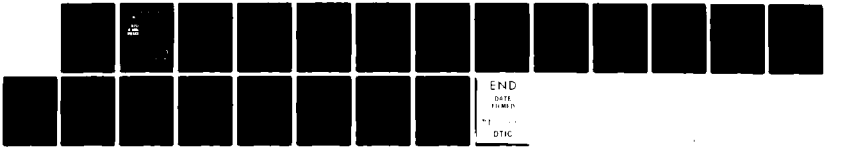

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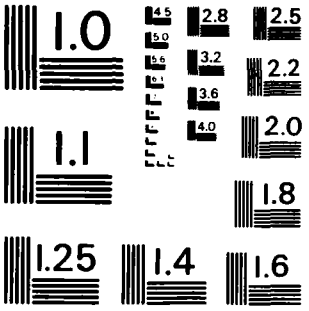

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ONR LONDON CONFERENCE REPORT

C-15-83

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OFFICE OF NAVAL RESEARCH

BRANCH OFFICE LONDON ENGLAND

THE 11TH INTERNATIONAL CONGRESS ON ACOUSTICS

CHESTER McKINNEY
WITH AN APPENDIX BY DAVID BLACKSTOCK (APPLIED RESEARCH LABORATORIES, THE UNIVERSITY OF TEXAS)

21 SEPTEMBER 1983

UNITED STATES OF AMERICA

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This report provides an overview of trends in acoustics research, based on the subject matter of the 11th International Congress on Acoustics. The report includes an appendix, written by David Blackstock (Applied Research Laboratories, The University of Texas). The appendix deals with nonlinear acoustics at the congress.

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CONTENTS

THE 11th INTERNATIONAL CONGRESS ON ACOUSTICS

1 INTRODUCTION

The 11th International Congress on Acoustics (ICA) met in Paris, France, from 19 through 27 July 1983. The ICA convenes every 3 years and is the only international meeting that covers all of the technical areas of the broad field of acoustics--ranging, for example, from musical to psychological to underwater acoustics. Each meeting is jointly sponsored by the International Commission on Acoustics (one of 12 such commissions of the International Union of Pure and Applied Physics) and the leading acoustics organization of the host country. For this meeting, the host was Groupement des Acousticeans de Langue Francaise (GALF, organized in 1948). Table 1 lists sites for the other ICA meetings, together with figures on attendance and contributed papers.

For two primary reasons it is not feasible to prepare a detailed summary of the technical sessions. For a meeting containing over 750 papers, it would be a monumental task to prepare a reasonably comprehensive summary. Furthermore, such a task would require one or more experts to cover each of the major fields of acoustics. Since there were usually about 10 simultaneous sessions, I personally only attended the oral presentation of about 80 papers. Therefore I have chosen to tabulate certain general statistics, make a few interpretations and observations, and invite the reader to make other interpretations and draw his own conclusions. A summary of each paper appears in the published proceedings.

Table 2 lists the number of registrants and contributed papers for each of the 44 countries represented. (The table was compiled from the preregistration list and a later supplement. The final total registration may have been slightly higher.) These figures provide some insight into the level of acoustics research in various countries, but the numbers should be interpreted with caution. Attendance at meetings (and the presentation of technical papers) is a function of national population, distance from the meeting site, political policy, and perhaps other factors, as well as activity in the field of acoustics. For example, the small number of USSR attendants (and papers) is not representative of the high level of acoustics work in Russia. As one might expect, France heads the list in both attendants and papers. Japan's third place position in attendants and second place in contributed papers is impressive. China's delegation of 17, with 33 papers, probably is a valid indication of the growth of acoustics work in that country and the desire to participate with workers in other countries. In general it appears that research and development is increasing in several countries, including China, Japan, and South Africa. It is interesting to note that a large number of countries were not represented, including several European ones. Representation from South America was slight; no one from Central America attended.

2 TECHNICAL PROGRAM

The technical program comprised sessions of contributed papers grouped according to theme, invited survey papers (two each day), structured sessions (special topics), round table discussions, poster papers, equipment exhibits, and technical tours of interest to acousticians.

I found the general survey papers to be one of the best features of the meeting. These papers, listed in Table 3, were well chosen and the treatments were uniformly excellent (nine are published as a part of Vol. 8 of the proceedings). Reading these papers is a convenient way to get an overview of some of the most active current topics in acoustics. Comparatively few papers were presented in poster format; but some were very well done, and there seemed to be good interest in them. The proceedings include papers on most of the poster presentations. Most of the

equipment exhibits concerned acoustical instruments and materials for noise control.

Table 4 gives a breakdown of contributed papers according to subject matter and country (ranked in order of total number of papers). The table does not include the 11 invited general survey papers. It should be noted that the figures listed are based on the papers published in the proceedings. Not all of these papers were actually presented, but data on "no-shows" are not available. If the sessions which I attended were representative, then I would estimate that perhaps 10 percent of the scheduled papers were not presented. Also, the papers frequently were not presented by the author. Some 1000 papers were contributed, but the number selected was about 750 in order to limit the number of parallel sessions.

The 16 subject areas of the table are arbitrary to some extent; they are not completely aligned with the nine "themes" of the ICA, nor with the technical areas of the Acoustical Society of America. It is recognized that there is considerable interconnection between major areas. For example, many of the airborne sound and the measurement papers are strongly related to architectural acoustics and noise, both of which are also highly interrelated. Scattering is especially relevant to underwater sound. Considerable forcing was done in order to prevent excessive subdivision; e.g., acousto-optics includes fiber-optics, which might be considered part of the transducers area. Bioacoustics includes, for example, medical and animal acoustics. Papers on engineering, standards, education, and signal processing have been assigned to the major area of relevance. From left to right, the first six columns are traditional areas, while the last 10 are subsets of physical acoustics, engineering acoustics, and underwater sound. It is felt that this choice of subjects can help in making broad interpretations of the technical program.

The table provides some information on the type of acoustics work being done in each country, but again, caution is suggested. Underwater acoustics (to be discussed in more detail later) is a major field in several countries--e.g., US, USSR, UK, and France. But this is not reflected by the figures in the table. China, which presented a comparatively large number of papers, seemed to aim at showing something in almost each subject area. Furthermore, most of the Chinese papers included a combination of theoretical and experimental work, and were well presented (in English). There is strong evidence that China is building a strong, broadly based program in acoustics, and is familiar with the literature. The broad coverage of the Japanese program is evident.

When subject matter is considered, it is clear that this ICA was a major meeting for workers in physiological and psychological acoustics, speech, architectural acoustics, and noise and noise control. Musical acoustics was well represented with 45 papers. Airborne sound work (including transducers and measurements) had a larger part of the program than underwater sound (including transducers and measurements). Nonlinear acoustics was well represented with 26 papers, about equally divided between air and underwater work.

It is of interest to note the distribution of papers between theory and experiment. Of course many papers are combinations of the two, while some compare new theory with old data and vice versa. Papers from the fields of physiological and psychological acoustics, speech, industrial noise and noise control, and music were overwhelmingly experimental in nature. Architectural acoustics was heavy on, for example, description of measurements in auditoria, but also included a number of theoretical papers. Transducers were biased toward development and testing, while measurements were primarily descriptions of new experimental techniques. Shock and vibration, airborne sound, and underwater sound papers were

about equally divided between theory and experiment. A majority of scattering papers were theoretical in nature.

3 UNDERWATER ACOUSTICS AND TRANSDUCERS

Underwater acoustics, a field of strong interest to the US Navy, was not a major topic at this ICA. It is tempting to attribute this fact to military security restrictions; these undoubtedly are a factor, but surely not the only one. Meetings of the ASA are open and have large numbers of papers on the subject, as do other unclassified meetings (e.g., the April meeting at Bath University on Underwater Acoustics and the Sea Bed and the 1982 International Conference on Spectral Analysis and its Use in Underwater Acoustics). Regardless of the reason, few papers were identified directly with underwater acoustics. Nor did the meeting attract many Europeans who are heavily engaged in underwater sound research and sonar development.

Table 5 lists papers that relate directly to underwater sound. (Many other papers are of interest to the underwater sound community.) It can be seen that major subareas (e.g., propagation, ambient noise, absorption, and bottom interaction) are represented, but only sparsely. The titles are representative of the subject matter. In Cato's paper (2.91), excellent agreement between theory and experiment was shown, and that is rather surprising in view of what appeared to be an overly simple model for the actual experiment. Surprisingly, China was one of the major contributors, and interest in shallow water acoustics was evident. There were several papers on using acoustic signals to characterize the ocean sediment in shallow water (from China, Japan, and Capetown). Some of the results were encouraging but preliminary in nature.

Kurianov (USSR) gave a nice review paper on low frequency ambient noise in the deep ocean. As a paper intended for the general acoustics audience it cannot be faulted. He primarily summarized western experimental work of the past decade (about seven references) and discussed his own theoretical model (already published) which emphasizes the role of atmospheric turbulence. In brief, he did not include any new data or theory. His paper is *not* published in the proceedings, but upon request I can provide a copy.

The papers listed under the subject of scattering are mostly relevant to underwater sound applications, and these papers came mostly from groups in France and the US. The Varadans (Ohio State) continue to apply their T-matrix methods to scattering and propagation problems, and Gaunaurd and colleagues continue to use their resonant scattering theory to obtain solutions to scattering problems. These papers were mostly theoretical in nature; the authors provided extensive calculations and comparison with existing experimental work. In recent years there has been an explosion in the number of papers dealing with scattering from simple and complex targets, multiple layers, and bubbles. In listening to new papers I find that I am confused about what work in theory and experiment has and has not been done. I believe that the time is ripe for a new survey paper with some matrix tables to give one a feeling for which parts of the scattering puzzle are in place and which are still missing.

There were a few papers on underwater sound transducers and arrays (Table 6). Only one (2.98) dealt with array beam forming and steering. One used several element sizes to achieve wide bandwidth (2.94), while another (1.13) used variation in element area to achieve shading. Paper 2.96 used the "slant-plate" technique to form a directional beam. Papers 2.02 and 2.92 concerned the same basic transducer, with the latter employing an acoustic filter backing system to achieve a cardioid pattern. Most of the paper titles are self explanatory. There is considerable activity in several European countries in developing PVDF for transducers (e.g., UK and France), but there were no contributed papers on this topic and only one paper (from France) described a small PVDF hydrophone.

Sessler gave an excellent review paper on new types of transducers (electret, PVDF, PVF2, and fiber-optic) but there were no supplemental contributed papers for underwater sound devices, except for fiber-optics.

4 NONLINEAR ACOUSTICS, NOISE REDUCTION

A separate summary of papers on nonlinear acoustics prepared by David Blackstock is included as the appendix to this report; a combination of modesty and embarrassment prevents him from relating one story. David presented a paper which proved to be extremely interesting but, as he emphasized, did not advance the knowledge about nonlinear acoustics. In 1821-23 Parry, in his search for a northwest passage, measured the speed of sound over a 5645-foot path by firing a cannon, with observers recording delay time of hearing the shot after seeing the flash. On one evening several observers heard the command "fire" some 3/8 second after they heard the shot! Nonlinear acoustic effects, among others, have been suggested as a reason for the unusual observations. Blackstock showed, in a convincing manner, that such an explanation is not feasible. The embarrassment aspect is as follows. Blackstock's paper was the first one scheduled for a morning session on nonlinear acoustics. He and the session chairman walked into the meeting room together; the chairman called for Blackstock's paper, and David gave it to a very interested audience who asked numerous questions and made helpful comments. The point is that the chairman and Blackstock had gone to the wrong room and presented the paper to the wrong audience!

The use of active techniques for noise reduction is a fairly old subject, but interest and activity seem to be increasing (witness the 20 papers on the subject at Internoise '83). One of the ICA round tables was on the same subject, and 11 short papers were presented prior to discussion. It seems that most of the applications and experimental work have dealt with noise cancellation in ducts, which may be the easiest case to implement. Significant noise reduction has been achieved and a few systems are operational, but much R&D clearly remains to be done.

5 LANGUAGE

The ICA official languages are English, French, and German. There were simultaneous translations for the opening (general) session but not for any of the technical sessions. With few exceptions the oral presentations were made in the same language used in the papers published in the proceedings (Table 7).

Certainly a listener is handicapped if he is not fluent in the language of the presentation; however, having available the proceedings, with a four-page version of each paper, is an extremely valuable aid. Although figures are not available, I speculate that the percentage of papers not in English (primarily French) was higher for this meeting than for most of the prior conferences. Since the proceedings were available at the time of registration, it would be difficult to justify the heavy cost of simultaneous translation (in three languages for, typically, 10 parallel sessions). It is noted that if a speaker desires to maximize the size of the audience he reaches, the presentation should be in English, but there are other factors to be considered. It has been suggested that some group (e.g., ONR) should translate non-English papers into English for the benefit (primarily) of the US acoustics R&D community. English versions would be easier to read, but after reviewing the papers I feel that an interested person can obtain an adequate understanding of any specific paper with the aid of a small dictionary. For future consideration, printing titles in three languages would be useful and require little additional work for the authors or editors.

6 SATELLITE AND RELATED CONFERENCES

The Paris ICA was preceded on 15 and 16 July by two satellite symposia: Encoding and Decoding of Speech was held

in Toulouse, and Acoustic Radiation from Vibrating Structures in Lyon. In addition, there were five other international meetings held during the summer on special topics in acoustics that were not a part of the ICA and were not formally coordinated with the ICA. These included the Symposium on Noise and Health at Turin, Internoise '83 at Edinburgh (13 through 15 July), Ultrasonics International at Halifax, and others. The activities of the meetings just mentioned were summarized in a general session on the afternoon of the first day of the ICA.

The Symposium on Noise and Health was sponsored by The International Commission on Biological Effects of Noise (ICBEN) and was the fourth conference of this group. The work of the commission is conducted by eight specialist groups, and each group reported at the meeting.

The Symposium on Encoding and Decoding of Speech was attended by 120 people from 20 countries. There were a few invited papers, contributed papers in the poster format, and panel discussions.

Internoise '83 was attended by 700 people from 38 countries. Some 400 papers were presented in seven parallel sessions over a 3-day period. The emphasis was on engineering aspects of noise and noise control. Initially an ICA satellite symposium on active acoustic methods for noise reduction had been planned but was canceled in view of the dates for the Internoise Conference. On this subject there were 20 papers at the Edinburgh meeting. Internoise is a major annual conference; the subject matter is of considerable interest to the US Navy. (See Dr. Alan Powell's article in *ESN* 37-10/11:426-428 [1983]).

The Lyon Symposium on Acoustic Radiation from Vibrating Structures was attended by 148 people (63 percent from France). The program included six invited lectures and 38 contributed papers. The proceedings (240 pages) are available from GALF.

The Halifax Ultrasonics International was the fourteenth in a series, sponsored by Butterworth Publications and *Ultrasonics* (a journal). This meeting was co-hosted by the Canadian Acoustical Society. About 180 attendants heard 134 papers over a 3-day period. Although emphasis was on nondestructive testing (NDT), medical ultrasonics, and acoustic microscopy, the technology covered is of interest to the US Navy.

In brief there were a lot of acoustic meetings this summer. They represent considerable investment in time and money by individuals and their sponsoring agencies. One has the impression that there was considerable overlap between meetings for several of the topics.

7 THE PROCEEDINGS

A four-page version of each contributed paper, and some of the invited papers, appears in eight volumes of the proceedings with a total of 3346 pages (Table 8). These eight volumes were distributed to each attendant at registration. The proceedings provide excellent documentation of the papers presented at the technical sessions. Typically, each paper includes about three pages of title, text, and references and one page of graphs, data, or photos (about four figures). The papers had to be submitted for publication by 15 November 1982, more that 8 months before the congress. As might be expected, some authors presented information developed after their papers were submitted. If my experience is typical, about 25 percent of the orally presented papers included significantly more data or information than those published in the proceedings.

Copies of the proceedings may be purchased at FrF600 for the full set, or FrF100 per individual volume. Proceedings for the Lyon Symposium are FrF100, and for the Tolouse Symposium, FrF200. The address for mail orders is:

Groupement des Acousticiens de
Langue Francaise
C.N.E.T. Lannion A.
Route de Tregastel BP40
22301 Lannion Cedex, France

A set of proceedings was included in the registration fee, but for those activities not represented at the ICA, it is suggested that a set is a worthwhile addition to a reference library on acoustics.

8 CONCLUSION

It is commonly said that one attends a scientific meeting to hear reports on the most current work and to hold informal conferences. Certainly there were plenty of papers to hear at the 11th ICA; at best one could only hope to sample those presented. Scientific and technical papers come in all sizes, shapes, and colors. Some use modern computers to make calculations that were not deemed feasible or worthwhile a decade or more ago. Some use a new technique to solve an old problem, and these can be useful if they provide new insights into the physics of the problem. Some provide simple ways to solve problems. Some make modest extensions to existing work. Some are little more than textbook problems. Some relate re-inventions and re-discoveries. All of these types of papers have a value and contribute to the overall body of knowledge in a field, but they are not very exciting. The ICA had its share of such papers--like most other meetings. One hopes to see papers with new--perhaps puzzling--data, or papers which formulate new problems, or which solve difficult, known problems of high interest. Such papers were not very evident. Perhaps I am not perceptive enough to recognize those papers which a decade from now will be universally recognized as classics.

The matter of the value of meeting colleagues and holding informal discussions in the halls and bars deserves some comment. In a large meeting such as the ICA it is likely that only about 10 percent of those present are in one's own field of work, and it is not easy to identify that 10 percent. Perhaps attendants should have different colored badges, the color being keyed to the primary field of interest. And when name tags are typed with print only 0.1 inch high, it is extremely difficult to read them from distances greater than 2 feet. In brief, although I met some new people, I failed to identify some who would have been of special interest to me. I had many useful and informative discussions during the meeting, but most were with people I already knew.

Nine days make a long meeting (8:45 am until 6:30 pm), 750 papers are a lot, and 1100 people are a crowd. I prefer smaller meetings on special topics. The International Commission on Acoustics is fully aware of the problems of the ICA type of meeting and is considering whether the present format is the best one. A great deal of work by many people is required to conduct an ICA, and most of the arrangements for the Paris meeting were excellent. Having the proceedings available at the start of the congress is standard for the ICA and is a most valuable feature. Attendants and the acoustics community undoubtedly will make good use of the multiple volumes for some years. The proceedings, in combination with the registration list (which includes addresses), help one identify activities and individuals involved in acoustics research. It would be helpful to distribute a listing of authors and papers (including date of scheduled presentations) before the meetings.

Table 1

International Congress of Acoustics

ICA No.	Year	Country	Participants	Papers
1	1953	Netherlands	310	90
2	1956	US	800	300
3	1959	West Germany	1050	320
4	1962	Denmark	900	310
5	1965	Belgium	1100	480
6	1968	Japan	900	470
7	1971	Hungary	1200	700
8	1974	UK	1300	700
9	1977	Spain	1340	710
10	1980	Australia	720	600
11	1983	France	1100	755
12	1986	Canada	----	---

Table 2

Registration and Contributed Papers, by Country

	Country	Registrants	Papers
1.	France	349	189
2.	US	115	82
3.	Japan	100	90
4.	Germany (West)	99	68
5.	UK	77	58
6.	Denmark	36	12
7.	Belgium	32	22
8.	Canada	30	23
9.	Netherlands	24	17
10.	Italy	21	9
11.	Spain	19	13
12.	USSR	19	19
13.	Australia	18	13
14.	Poland	18	24
15.	China	17	34
16.	Sweden	14	7
17.	India	10	6
18.	Switzerland	10	1
19.	Norway	9	3
20.	Hungary	8	9
21.	Czechoslovakia	6	6
22.	Finland	5	6
23.	Israel	4	1
24.	Yugoslavia	4	6
25.	Argentina	3	5
26.	Bulgaria	3	13
27.	Greece	3	1
28.	Portugal	3	---
29.	South Africa	3	3
30.	Syria	3	---
31.	Hong Kong	2	1
32.	Iran	2	1
33.	New Zealand	2	---
34.	South Korea	2	---
35.	Algeria	1	---
36.	Brazil	1	1
37.	Chile	1	---
38.	Cuba	1	1
39.	Egypt	1	2
40.	Ghana	1	---
41.	Roumania	1	6
42.	Singapore	1	1
43.	Iraq	---	1
44.	Nigeria	1	---
	Unidentified	28	---
	Total	1078	755

Table 3

Invited General Survey Papers
(Published in Vol. 8 of Proceedings)

1.	"How We Hear," N.Y.S. Kiang (paper not published)	US
2.	"The Acoustics of Quantum Liquid Helium Near Absolute Zero," I. Rudnick	US
3.	"Low Frequency Ambient Noise in Oceans. Theory and Experiment," B.B. Kurianov (paper not published)	USSR
4.	"Electroacoustic Transducers: Recent Progress and Future Trends," G.M. Sessler	West Germany
5.	"Photoacoustic and Current-Injection-Induced Acoustic Spectroscopy in Semi-Conductors," Nobuo Mikoshiba	Japan
6.	"Atmosphere Propagation of Sound: Progress in Understanding Basic Mechanisms," J.E. Piercy, T.F.M. Embleton, G.A. Daigle	Canada
7.	"Toward a Better Understanding of Source Acoustics," E.J. Richards	UK
8.	"La Synthese Numerique des Sons a Vingt-Cing Ans: Son Impact sur L'Acoustique Musicale," Jean-Claude Risset	France
9.	"Les Methodes de Calcue Numerique en Acoustique," Reynald Seznec	France
10.	"Nonlinear Hydroacoustics," Vladinic Ivanovich Timosheuko	USSR
11.	"Fifty Years of Acousto-Optics," Robert Mertens	Belgium

Table 4

Distribution of Papers by Country and Topic

	Psychological Physiological	Speech	Musical	Architectural	Shock & Vibration	Noise and Noise Reduction	Airborne Sound Propagation, etc.	Underwater Sound	Scattering	Physical Acoustics, General	Acousto-Optics	Nonlinear & Finite Amplitude	Transducers (air)	Transducers (underwater)	Measurements, Methods, etc.	Bioacoustics	TOTAL
France	24	21	15	21	8	32	6	1	8	15		7	2	3	22	4	189
Japan	11	14	6	7	4	10	5	1		3	1	6	9	3	10		90
US	13	7	5	2	5	8	2	4	13	6	3	6		2	1	5	82
West Germany	9	1	3	5	3	15	11		1	2	2	1	5	1	7	2	68
UK	5	6	5	10	5	13	5			1	1			1	6		58
China	3	2	1	6		2	2	4	2	6	1			3	1	1	34
Poland	1	2	2	1	2	3	1		1	4	1	2		2	2		24
Belgium	2	2		6		4		2			3				3		22
Canada	9	1		6	1	3	2						1				23
USSR				2	1	1		2		6	3	2	1			1	19
Netherlands	6		2	5		2	1								1		17
Australia	2	2	1	4			1	1		1					1		13
Spain	1	2		3		2	1	2		1					1		13
Denmark	1		1	1	1	2		1				1	3		1		12
Bulgaria		2		4	1	3										3	13
Italy	2	2		2				1		1				1			9
Hungary		1	1	2	1	2							1		1		9
Czechoslovakia		1		1						1	1				2		6
Finland		1			1	2									2		6
Sweden	2	2		1	1										1		7
India	1	1	1	1		2											6
Roumania			1	3	1	1											6
Yugoslavia	1				2								1		2		6
Argentina		1		1		1									1		5
Norway	1	1		1													3
South Africa								1	1			1					3
Egypt	1				1												2
Switzerland	1																1
Israel					1												1
Greece				1													1
Singapore				1													1
Brazil					1												1
Iraq	1																1
Nigeria					1												1
Iran			1														1
Hong Kong						1											1
Cuba																	1
TOTAL	97	72	45	97	41	108	37	20	26	47	16	26	23	16	65	15	755

Table 5

Underwater Acoustics Papers

Page

2.73 The spatial filtering of the acoustical normal modes in shallow water. Techao Wang, Erchang Shang, Jixum Zhou, Binggchum Li, Enshen Lou, Yin Zhang (China).

2.74 Sound absorption in sea water: chemical mechanisms. Robert H. Mellen (US).

2.76 A new method for the numerical prediction of average transmission losses in shallow water. Renhe Zhang, Jianli Zhou (China).

2.85 Sea bed characterization and the determination of the anglular variation of backscattering strength. Philip Denbigh, Arthur Tucker (Capetown, South Africa).

2.86 Influence of temperature profiles on parametric excitation of modes in shallow water. Leif Bjorno (Denmark).

2.87 Ultrasonic reflection from sea floor soft mud layer. Masahatsu Ohgaki, Motoyoshi Akujima, Sumitka Kihara (Japan).

2.88 Etude du changement du signal acoustique lors de sa propagation dans un milieu avec gradient de vitesse. Rafael Carbo, Marina Camarasa, Carlos Ranz, Ana Soler (Spain).

2.89 Remote sensing of attenuation of sound in marine sediments. Jin-Sheng Meng, Ding-Hua Guan (China).

2.810 Normal-mode theory of the average reverberation intensity in shallow water. Renke Zhang, Guoliang Jin (China).

2.811 Experimental and theoretical statistical distributions of underwater acoustic propagation losses. Melvin Pedersen, Robert McGirr (US).

2.812 Sound Propagation over a seamount. Finn B. Jensen (Saclant ASW Centre, Italy).

2.816 Coupled mode theory for an inhomogeneous oceanic wave guide with a time varying, randomly rough sea surface. C.A. Boyles, L.B. Dozier (US).

2.817 Characterisation of recent estuarine and marine sediments by measuring the acoustic reflectivity. A. Cops, St. Wartel (Belgium).

2.818 Mean sound speed profile and its distribution in the abboran sea. A. Soler, C. Ranz, R. Carbo, M. Camarasa (Spain).

2.91 Theoretical and measured noise from water wave orbital motion. D.H. Cato (Australia).

1.36 On sound propagation in moving stratified medium. Leonid Liamshev, (USSR).

1.38 Caustics, catastrophes, and wave fields. Yury Kravtsov, Yury Arlov. (USSR).

1.45 A modified Kirchoff approximation for rough surface scattering. D.H. Berman, J.S. Perkins (US).

28.13 Observation de vitesses sismiques lentes dans les sediments meubles de subsurface sous faible profondeur d'eau. P. de Maeyer (Belgium).

Table 6

Underwater Sound Transducers

2.02 Modelisation d'un vibrateur trilame d'hydrophone. Jean Puoliquen, Christian Granger, Andre Defebvre (France).

2.03 Etude d'un resonateur a alliage magnetostrictif fer-terres rares en vue de son utilisation en acoustique sous-marine. Daniel Jousselin, Daniel Royer, Eugene Dieulesaint (France).

2.04 Fakussiereude und Mehrschichtige Ultraschallwandler aus PVDF. Michael Platte (West Germany).

2.92 Conditions d'obention de la directivite cardioide d'un hydrophone. Andre Defebvre, Jean Pouliquen, Jean-Pierre Deparis (France).

2.94 Broadband underwater trandsucer array and its acoustic field. Zong-fa Gao, Qi-Chang Xu (China).

2.95 Ultrasonic omnidirectional transducer for use in deep seas. Motoyoshi Okujima, Shigeo Ohtsuki, Hiroyuki Hachiya (Japan).

2.96 An acoustic delay system to obtain directional underwater radiation. J.A. Gallego-Juarez, F. Montero de Espinosa, A. Barone (Spain-Italy).

2.98 An analog quadrature phase-delay sonar beamformer. Andrzej Stepnowski, Roman Salamon (Poland).

1.13 The experiment and analysis of compressing the side-lobes by means of weighting the area of the phased array elements. Zhao Hengyuan, Chen Qimin, Liu Shuyan, Ma Yuying (China).

6.18 A fiber optic lever hydrophone. Frank Cuamo (US).

6.110 Vibration and acoustic radiation of piezoelectric transducer FEM-equivalent circuit analysis. Xiao-qi Bao, Qi-chang Xu, Te-Chao Wang (China).

6.113 Piezomagnetic alcofer transducers for the frequencies 22 and 23 kHz. Zbigniew Kaczkowski (Poland).

Table 7

Languages of Papers

Language	Number of Papers	Percent
English	498	66
French	221	29
German	36	5
Total	775	100

Table 8

The Proceedings

Volume	Topics	Pages
1.	Physical Acoustics Audio Frequencies and Infra-Sound	360
2.	Physical Acoustics Ultrasound, Hypersound, Underwater Acoustics	480
3.	Physio- and Psycho-Acoustics	348
4.	Oral Communications and Musical Acoustics	466
5.	Shock, Vibrations, and Solid State Acoustics Industrial Acoustics	500
6.	Measurements, Transducers, Electroacoustics	396
7.	Applied Acoustics Architecture, Town and Country Planning	420
8.	General Conference Papers (Invited) General Nature Papers Round Table Papers Structured Papers Index	376
	Total	3346

APPENDIX:

NONLINEAR ACOUSTICS AT THE 11TH ICA

by

David T. Blackstock
(Applied Research Laboratories, The University of Texas at Austin)

Two long sessions, essentially one day each, contained most of the papers on nonlinear acoustics. A few isolated papers appeared in other sessions. Table A1 is a list of all the papers in nonlinear acoustics.

The breakdown by country of all papers in nonlinear acoustics (invited and contributed), with the same data for the 1971 (Budapest), 1977 (Madrid), and 1980 (Sydney) congresses is shown in Table A2. An asterisk indicates that one of the papers was invited. The "Other" category at the bottom of the table is for countries never represented by more than one paper during the total of all four congresses. Some valid conclusions may be drawn from the table. Japan has certainly increased its effort in nonlinear acoustics. In many smaller countries the output is largely due to one or two persons who consistently present papers at ICA Congresses, e.g., Bjørnø (Denmark), Dyba and Zółtogórski (Poland), and Jongens (S. Africa). As a measure of worldwide effort on nonlinear acoustics, however, the table is very misleading. The major two countries by far are the US and USSR (the effort in the USSR probably exceeds that in the US by a great deal), but that fact is not to be gleaned from the table. England is completely missing from the table; yet much excellent work is done by English scientists and engineers. One concludes, therefore, that an ICA Congress is not a uniform forum for papers in nonlinear acoustics. Nevertheless, it does offer a unique opportunity for those who attend to exchange ideas. It is one of the very few meetings where one can find Russian workers in the field, even though the number of Russians who attend is never large.

Table A1

Papers in Nonlinear Acoustics

Theme 19 (morning and afternoon, 22 July)

19.1	Propagation of a weak shock followed by a tail of arbitrary wave form	D.T. Blackstock (US)
19.2	A theoretical study of the influence of dissipation effects upon spectrum evaluation of intensive acoustic noise	R. Dyba (Poland)
19.3	Energy dissipation in a process of shock formation of N wave	A. Nakamura, T. Nakamura (Japan)
19.4	Waveform variation on axis of pulsed parametric source in air	T. Nakamura, A. Nakamura (Japan)

19.5	Examination of spherical and cylindrical acoustic waves of finite amplitude	B. Zóltogórski (Poland)
19.6	An application of nonlinear interaction of sound waves to the loudspeaker fundamental and improvement	M. Yoneyama, J.-I. Fujimoto (Japan)
19.7	Finite amplitude acoustic wave propagation in a cylindrical waveguide	J.H. Ginsberg, H.C. Miao (US)
19.8	Shock structure and shock associated noise of supersonic jets	C.K.W. Tam (US)
19.9	Difference of propagation characterstics between an N-wave and a repeated sawtooth wave	W. Watanabe, Y. Urabe (Japan)
19.10	Etude de l'onde acoustique émise par un éclateur de decharge électrique en vue de la source ponctuelle sphérique d'impulsion acoustique	T. Otani, M. Takeda (Japan)
19.11	Features of an underwater explosion record as function of detonation depth.	D. Epstein (US)
19.12	Rayonnement non linéaire d'une source plane immergèe à répartition d'amplitude gaussienne	R. Burvingt (France)
19.13	Evaluation du champ de pression autour des bâtiments engendré par une onde d'explosion	G. Nguyen Van Chi, A. Warluzel (France)
19.14	Multiple reflection of shock wave in a layer structure	T. Yasumoto, K.-I. Kondo, A. Sawaoka (Japan)

Theme 22 (afternoon 26 July and morning 27 July)

22.1	Improving the conversion efficiency of the parametric acoustic array	A.W.D. Jongens (South Africa)
22.2	Parametric acoustic array formed by noncollinear primary beams in a dispersive fluid	M.F. Hamilton, F.H. Fenlon (US)
22.3	Conjugason de phase en acoustique par interaction de quatre ondes	B. Perrin (France)
22.4	Röntgenblitzfotografie von Wirbelbildung bei Stosswellenausbreitung and dem Übergang von periodischer Struktur zum Chaos bei der Kavitation	R. Germer, R. Schutt (West Germany)
22.5	Propagation non linéaire d'une onde de surface à l'interface plane nickel-air	J.-L. Izbicki, G. Maze, J. Ripoche (France)

22.6	Shock waves in deformable piezoelectric materials	B. Collet (France)
22.7	The non-linear interactions in the liquid with gas bubbles	K.A. Naugolnykh, S.A. Rybak (USSR)
22.8	Détection et calibration de bulles par analyse de leur mouvement non linéaire	C. Cachard, M. Chamant, G. Giminez (France)
22.9	Non-linear acoustic diagnostics of discrete inhomogeneities in liquids and solids	L. Ostrovskii, A. Sutin (USSR)
22.10	Relative influence of the phasical parameters involved in ultrasonics aerosol coagulation	E. Riera, J.A. Gallego, V. Ulin (Spain)
22.11	Propagation of ultrasonic waves in nonlinear solids of cubic, hexagonal and trigonal symmetry	M.A. Breazeale (US)

Isolated papers in other sessions

13.1	Une représentation mixte en acoustique linéaire et non linéaire dans les écoulements	B. Poiree (France)
17.6	Acoustic radiation force on a sphere in plane, cylindrical and spherical standing wave fields	M. Barmatz, P. Collas (US)
21.11	Ondes élastiques non linéaires engendrées par des solitons dans les cristaux ferroélectriques	J. Pouget, G. Maugin (France)
21.12	Non-linear interactions in nematic crystals under periodic elliptical deformation	O.A. Kapustina, E.N. Kozkevnikov, G.N. Yakonvenko (USSR) (authors absent)
23.14	Development of bubble cavitation and wave structure in real fluid	V.K. Kedrinskii (USSR)
23.15	Approximate formulas for the maximum amplitude of oscillating bubbles	R. Nabergoj, A. Francescutto (Italy)
26.5	Nonlinear focusing effects in ultrasonic imaging	L. Bjørnø, P.A. Lewin (Denmark)
28.6	Influence of temperature profiles on parametric excitation of modes in shallow water	L. Bjørnø (Denmark)
65.8	High-speed holography and speckle photography of shock wave propagation in air	D. Mach, K. Hinsch, H. Helmers (West Germany)

Table A2

Nonlinear Acoustics Papers by Country

Country	1971	1977	1980	1983	Totals
Belgium		2	1		3
Czechoslovakia	1	1			2
Denmark		1	2	2	5
France	3*	3	2	8	16
West Germany	1	1½		2	4½
Italy	1			1	2
Japan	1	6	3	6	16
Poland	1	3	2	2	8
South Africa			½	1	1½
Spain		2		1	3
US	3	10½*	3	7	23½
USSR	5*	4	4	5*	18
Other	1	1	3½	0	5½
TOTAL	17	35	21	35	108